

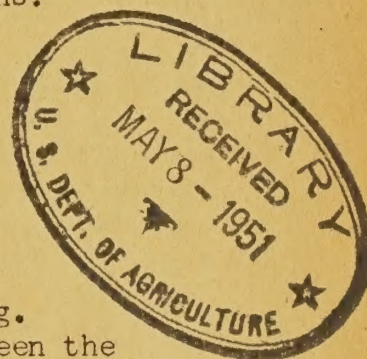
2 U.S. UNITED STATES DEPARTMENT OF AGRICULTURE
Rural Electrification Administration.

February 6, 1951⁵⁰

HORIZONTAL SURFACE CONDENSER SPECIFICATIONS

I. General

- A. These specifications state the conditions and requirements applicable to the supplying of surface condensers for REA-financed systems. They apply to _____ ** surface condenser(s) complete with auxiliary equipment and accessories described hereinafter, to serve Turbine Generators of _____ ** KW nameplate rating under the conditions and requirements stated below. Surface condensers and other equipment specified herein shall comply with the "Standards of Heat Exchange Institute," unless specified otherwise below, and with the additional requirements of these specifications. Pump design shall comply with the "Standard of the Hydraulic Institute," electric motors shall conform to the applicable standards of NEMA, AIEE and ASA.
- B. The following symbols are used throughout the specifications:
- ** to be determined by the project engineer.
- ~~pp~~ to be determined by REA for each project.
- C. The following items will be provided by the purchaser:
1. foundation.
 2. foundation bolts, washers, anchor plates and grouting.
 3. all piping, valves and fittings, including that between the condenser and auxiliaries, except as otherwise noted in these specifications.
 4. all electric wiring and motor controls.
 5. free use of station facilities, including crane and crane operator.
 6. all supplies necessary for starting up and test.
 7. drawings of foundations and supporting structures.
 8. all necessary openings into building through which equipment is to be passed as well as shoring of floors and items of similar nature.
 9. all instruments and gauges.
 10. hotwell and make-up level controllers.



- D. All exposed unfinished work shall be thoroughly cleaned, smoothed, and before leaving the factory, painted with one coat of shop paint. All parts shall be carefully boxed or otherwise suitably prepared for shipment to insure against damage during shipment.

II. Application of Condensers

The turbine generators which the surface condensers will serve will be ASME-AIEE Preferred Standard Turbine Generators (AIEE Nos. 601 and 602, latest revision) of the ratings stated below. The surface condensers will be set with tubes at right angles to the turbine shaft and bolted rigidly to the turbine nozzle with spring supports and screw jacks between condenser feet and foundations..

Normally all extraction openings on the turbines will be used, and under that condition, the turbine generators will deliver 110% of their kilowatt nameplate rating with the steam flows to the condenser listed below. The circulating water will be **

(state source, water analysis,

pH, turbidity).

III. Basic Design Conditions (for each condenser)

1. Turbine-generator nameplate rating, KW:	15,000	20,000	30,000
2. Basic flow diagram :	S1	S1	S2
3. Steam flow to condenser with all heaters in service, at 110% nameplate rating and 2½" Hg abs. back pressure, lb/hr.:	114,000	150,000	220,000
4. Tubes:			
a. effective area, sq. ft.:	14,000	18,000	27,500
b. size O.D. and BWG:	7/8"-18	7/8"-18	7/8"-18
c. number :	3,057	3,930	5,456
d. effective length, feet:	20'-0"	20'-0"	22'-0"
e. Cleanliness factor %:	85	85	85
5. Circulating Water			
a. Quantity gpm:	15,450	20,500	28,600
b. Number of passes :	2	2	2
c. Direction of flow:	first through lower, then through upper pass.		

6. Water boxes:
- | | | | |
|---|--------------------------------|---------------|---------------|
| a. Type: | Divided/Non-divided $\phi\phi$ | | |
| b. Working pressure, psig.: | _____ | | |
| c. Inlet and outlet openings, diameter: | _____ | | |
| for condenser surface of ... | 14,000 sq.ft. | 18,000 sq.ft. | 27,500 sq.ft. |
| non-divided water boxes | 30 in. | 36 in. | 42 in. |
| divided water boxes | 24 in. | 30 in. | 36 in. |
7. Condensate pumps (each pump):
- | | | | |
|------------------------------|--------------------|-------|-------|
| a. Capacity, gpm: | 315 | 420 | 600 |
| b. Total dynamic head, ft. : | ___** | ___** | ___** |
| c. Speed, rpm: | Not to exceed 1800 | | |

IV. Equipment Included with each Condenser

1. ONE, HORIZONTAL SURFACE CONDENSER, including the following:
2. WELDED SHELL AND NECK of flange quality copper bearing steel ASTM-285, Grade C.
3. BOLTS AND GASKET for connecting condenser to turbine. (A template for drilling the steam inlet will be furnished to manufacturer).
4. WATER BOXES with hinged manhole covers giving easy access to tube ends; and with inlet and outlet circulating water openings, flanged, faced and drilled for 125 lb. American Standard. The material of the water boxes and manhole covers shall be cast iron.
5. TUBES of Admiralty metal, type _____** per ASTM-B111.
6. MUNTZ METAL TUBE SHEETS per ASTM-B171 and copper bearing steel tube support plates per ASTM-A285, Grade C, flange quality.
7. INTERNAL AIR COOLER.
8. STORAGE TYPE HOT WELL integral with shell, including two gauge glasses.
9. SPRING SUPPORTS AND SCREW JACKS.
10. OTHER CONNECTIONS:

2½ in. and larger shall be flanged in accordance with the 125 lb. American Standard; 2 in. and smaller to be screwed.

One after condenser drain.)
One inter condenser drain.) } or dual drainer.

One turbine shell drain and leakoff.
One condensate recirculating.
One drain from gland water collecting tank.
One emergency drain from drain cooler.
One air vent from stage heaters.
One low vacuum trip connection.
One make-up inlet.

Air Outlet Connections.

One pipe tap for vacuum gauge.
Two vents from condensate pumps.

Connections on hotwell:

One or two condensate suction(to suit purchaser.)
Two pipe taps for float control (hotwell level control)
Two pipe taps for float control (make-up level control)
Two pipe taps for gauge glasses.

Connections on water boxes:

Drains and Vents to suit.

11. ONE, TWIN ELEMENT, 2 STAGE STEAM OPERATED AIR EJECTOR, including inter and after surface type condensers, integral steam piping, steam shut-off valves hand-throttle valve (from 350 lb. 900F), steam strainer, loop and trap, relief valves for shell if shell can be subjected to pressures exceeding 200 psig, pipe taps on steam headers for owner's instruments, and automatic thermostat and valve to recirculate condensate to hot well limiting its temperature rise in inter and after condenser when condensate is of insufficient quantity for ejector condenser.
12. ONE DIRECT READING AIR LEAKAGE METER, for mounting on air outlet from the after condenser.
13. ONE NON-CONDENSING SINGLE STAGE HOGGING JET for evacuating the condenser and system.
14. TWO, MULTI-STAGE HORIZONTAL CENTRIFUGAL CONDENSATE PUMPS with motors by a manufacturer approved by the purchaser. Control equipment and wiring are not included.

15. GASKETS AND OTHER MOUNTING DETAILS for water boxes, waterbox covers and manhole covers.
16. ONE SET OF SPECIAL TOOLS AND WRENCHES used for maintenance and repair of the foregoing equipment (One set sufficient if more than one condenser is specified).

V. Design Details

A. Condenser shell:

1. The condenser shell shall be provided with suitable supporting lugs or feet.
2. The condenser neck shall be flanged, drilled and faced to suit the turbine nozzle.
3. The following are tentative limiting dimensions: **
 - a. Vertical distance, basement floor to bottom of structure carrying turbine exhaust: _____' _____"
 - b. Horizontal distance between foundation columns: _____' _____"

B. Tubes:

1. The tubes shall be in strict conformance with all provisions of ASTM-B111.
2. The tubes shall be belled and rolled at the inlet, and rolled at the outlet ends.
3. Longitudinal expansion shall be compensated by adequate means upon installation.
4. The tubes shall be so arranged that they will drain.

C. Tube Sheets and Support Plates:

1. Tube sheets and support plates shall be drilled, reamed, chamfered and radiused.
2. The drilled area shall not exceed 26% of the total tube sheet area exposed to vacuum.
3. Support plates shall be so spaced as to prevent harmonic vibration.

D. Hotwell:

1. The hotwell for a condenser surface of 14,000 sq.ft. 18,000 sq.ft. 27,500sq.ft shall be of sufficient capacity to store not less than
1,150 gals. 1,500 gals. 2,200 gals
above min. net positive suction head
required by pumps at 100% rated
capacity.
2. The area of the surface of the condensate shall be such that the quantity of steam condensed at max. load in 1 minutes equals a change in water level of not
more than
6" 8" 9"

E. Water Boxes:

1. Each water box shall have four manhole openings on both water box heads.
2. The manhole openings shall be at least 18" in diameter (or if elliptical or rectangular, at least 18" on the horizontal and 16" on the vertical axis).
3. The manhole covers shall be hinged on the side.

F. Air Ejector:

1. Each two stage element shall be designed for capacity required by the "Standard of the Heat Exchange Institute." (assumed at 1" Hg abs. and 71.5F saturation temperature.)
2. The ejector condensers shall be cooled with condensate from the main condenser.
3. The inter and after condensers shall be equipped with tubes of: 90-10 cupro-nickel/stainless steel.**
4. The inter and after condensers shall be suitable for a condensate pressure of 200 psig.

G. Hogging Ejector:

The hogging ejector shall have a capacity sufficient to remove _____ cfm** of free dry air leakage and to evacuate the system of approximately _____ cu.ft.* so as to produce a vacuum of 15 inches Hg. within 15 minutes.

* Turbine generator manplate rating kw:	15,000	20,000	30,000
Volume to be evacuated during first 15 minutes, cu. ft.	2,800	3,500	6,000

H. Condensate Pumps

1. Type: Bronze fitted with cast-iron casing.
2. Impellers: hydraulically balanced, opposed.
3. Casing: Horizontally split.
4. Stuffing boxes: under pressure
5. Openings: one suction and one discharge, in lower half of casing.
6. Motor Drive: Constant speed induction, drip-proof 440 v, 3-phase, 60 cycles, 40 C rise, across-the-line starting.
7. Windings Insulation: boiler house type equal to GE 1007.
8. Bearings: Ball
9. Bedplate: drip lip drip collecting design, common for motor and pump.
10. Coupling: Fast flexible or equal.
11. Coupling guards: in conformance with State and National Safety Council requirements.

VI. Tests

A. Shop Tests:

1. The manufacturer shall subject the condenser to a hydrostatic test as prescribed in the "Standards of Heat Exchange Institute."
2. The pump casings shall be tested hydrostatically with a pressure not lower than $1\frac{1}{2}$ times design pressure.

B. Field Tests (at Purchaser's option)

1. The assembled condenser may be tested after installation in conformance with the ASME "Test Code for Steam Condensing Apparatus."
2. The condensate pumps may be tested after installation in conformance with the "Standard of Hydraulic Institute."
3. Manufacturer's representatives may be present at the manufacturer's expense.

VII. Data Required with Bid

A. Condenser:

1. Weight including tubes:

- a. Empty
- b. Operating
- c. Steam space, filled with water, tubes empty:
- d. Steam and water spaces flooded:

lbs: _____

2. Dimensions:

- a. Length, over-all
- b. Height, incl. neck
- c. Width, over-all

ft.in. _____

3. Thickness of shell

in: _____

4. Friction loss through condenser
tubes and water boxes

ft. Water: _____

B. Hotwell:

1. Dimensions:

- a. Length
- b. Height
- c. Width

ft. in: _____
in: _____
in: _____

2. Thickness of steel,

in: _____

C. Tubes:

Means of compensation for longitudinal expansion :

D. Tube Sheets:

- 1. Thickness
- 2. Drilled area (See VC2)

in: _____
%: _____

E. Support Plates:

- 1. Thickness
- 2. Number

in: _____
: _____

F. Air Ejector Operation:

1. Min. initial steam conditions:

- a. pressure
- b. Temperature

psig: _____
F: _____

2. Max. allowable steam conditions:

a. pressure psig: _____

b. Temperature F: _____

3. Capacity of each 2 stage element of
air-vapor mixture:

a. At 1" Hg abs. and saturation temperature of 71.5 F lb/hr.: _____

b. At 2" Hg abs. and saturation temperature of 93.6 F lb/hr.: _____

4. Minimum amount of condensate required by ejector condenser

gpm : _____

G. Hogging Ejector Operation:

Min. allowable steam conditions at which
ejector will work:

1. pressure psig: _____
2. temperature F: _____
3. Capacity with 15" Hg suction - CFM free dry air : _____

H. Condensate Pumps:

1. Diameter of discharge opening	in:	_____
2. Diameter of suction opening	in:	_____
3. Pump speed, (full load)	RPM:	_____
4. Pump and motor efficiency at rating, (wire to water)	%:	_____
5. Required brake horsepower	HP:	_____
6. Rated horsepower of motor	HP:	_____
7. Submergence required	ft:	_____

I. Price addition for each extra foot of condenser neck over 4 ft. included in bid.

\$ _____

J. Performance Guarantees:

1. The bidder guarantees that under the "Basic Design Conditions (for each Condenser)" set forth in Section III of these specifications and under the assumptions cited below the performance of the condenser and other equipment covered by these specifications will be as follows:

a. Assumptions:

1. Cleanliness factor	%:	85
2. Heat rejected to condenser circulating water	BTU/lb:	950

b. Guarantees:

For a condenser surface of _____ sq. ft.* and circulating water flow of _____ gpm* the maximum pressure at the steam inlet will not be more than indicated in the column headed "in Hg. abs."

Circulating water in at: 50F 60F 70F 80F 90F

Steam flows (See Table below) in Hg. abs.

(25% load)	lb/hr:	---	---	---	---	---
(50% load)	lb/hr:	---	---	---	---	---
(75% load)	lb/hr:	---	---	---	---	---
(100% load)	lb/hr:	---	---	---	---	---
(110% load)	lb/hr:	---	---	---	---	---

2. The bidder also guarantees the following:
- .03 cc/liter oxygen content of hotwell effluent (maximum)
 - 0 F condensate depression
 - Amount of steam to jet, lb/hr. per element : _____
 - Amount of steam to hogging jet, lb/hr. : _____

Table

<u>Steam flows for:</u>	<u>15,000</u>	<u>20,000</u>	<u>30,000 KW</u>
at 25% load	33,000	42,500	62,000 lb/hr.
at 50% load	56,000	74,500	108,500 "
at 75% load	79,500	105,500	153,000 "
at 100% load	104,000	137,500	200,000 "
at 110% load	114,000	150,000	220,000 "

K. Miscellaneous Data:

- Performance curves for condenser (steam flow lb/hr. as abscissa, absolute pressure (inches Hg.) as ordinate).
- Dimension sketches for condenser and auxiliaries.
- Preliminary performance curves for condensate pumps.

VIII. Data Required from Successful Bidder

A. The successful bidder shall submit to the purchaser a certificate to the effect that the condenser tubes specifically:

1. Comply with Section 15 of ASTM-B111*concerning dimensions.
2. Comply with Sections 8, 9 and 11 of ASTM-B111*relative to tests.
3. Have an analysis as prescribed by Table I, of ASTM-B111*when tested and analyzed per Section 12.

*Reference is to 1948 Standard. Use latest revision.

B. The successful bidder will provide the following information concerning connections:

1. On condenser shell

in:

- a. After condenser drain
- b. Inter condenser drain
- c. Turbine shell drain and leakoff
- d. Condensate recirculating
- e. Gland water tank drain
- f. Emergency drain, drain cooler
- g. Air vent from stage heaters
- h. Low vacuum trip
- i. Pipe tap for vacuum gauge
- k. Make-up inlet

: _____
: _____
: _____
: _____
: _____
: _____
: _____
: _____
: _____
: _____

2. On hotwell

in:

- a. Suction opening
- b. Pipe taps (hotwell level control)
- c. Pipe taps (make-up level control)
- d. Pipe taps, gauge glasses

: _____
: _____
: _____
: _____

3. On water boxes

1. No. and size of drains
2. No. and size of vents

: _____
: _____

THE HISTORY OF THE UNITED STATES

The history of the United States is a story of growth and change. It begins with the first settlers who came to the Americas in search of a new life. They found a land of opportunity, but also a land of challenge. The early years were marked by conflict and struggle, as the settlers fought to establish their own communities and defend their rights. Over time, the United States grew from a small colony into a powerful nation, with a rich and diverse culture. The story of the United States is a story of the human spirit, of the pursuit of freedom and the dream of a better life.

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